A CONTINUUM TO CHARACTERISE AND SUPPORT TEACHER INTERPRETATION OF AN INNOVATIVE CURRICULUM

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A continuum for describing the degree to which teachers interpret the various features of a curriculum is presented. The continuum has been developed based upon the observation of classroom practices and discussions with a group of teachers who are using an innovative junior secondary mathematics curriculum. It is anticipated that the ongoing use of the continuum will lead to its improvement as well as the refinement of the curriculum, more focussed support for the teachers, improved student learning, and the building of explanatory theory regarding mathematics teaching and learning.

INTRODUCTION

This paper presents a continuum that characterises teachers' interpretation of the curriculum provided in an Australian Research Council (ARC) funded project titled *Accelerating the Mathematics Learning of Low Socio-Economic Status Junior Secondary Students (XLR8)*. In this paper, the *interpretation continuum* is a scale to describe the degree to which the teachers involved in the project interpret the project's intended curriculum and transform it into the enacted curriculum of their respective classes. The paper first provides an overview of the project and then summarises the literature and approach that has led to the development of the continuum. To illustrate the continuum's application, two teachers' interpretations of the innovative curriculum is presented. Ultimately, the continuum may aid in the development of theory regarding teachers' effective interpretation of curriculum innovations, such as the one proposed in the XLR8 project.

PROJECT OVERVIEW

The XLR8 project has been designed to develop theory and practice regarding the acceleration of junior secondary students (Years 8-9) whose level of mathematical achievement is nominally at a mid-primary school level (Year 4). The project aims to improve students' potential to enter Year 10 with the requisite knowledge to successfully study mathematics and follow this with further study or employment. The project, including its underlying conceptual framework and methodology has been presented previously (Cooper, Nutchey & Grant, 2013).

In short, to address the identified issue of underperforming students, design experiment (Cobb, Jackson & Munoz, 2015) is used to propose and iteratively refine a curriculum for acceleration (i.e., the intervention). The XLR8 curriculum is innovative because it has been designed to carefully explore the structure of mathematical knowledge in a nested, conceptually-focussed sequence that builds students' understanding from a

low-achievement level to age-appropriate level. To achieve this, the curriculum employs a pedagogy referred to as RAMR, standing for Reality-Abstraction-Mathematics-Reflection. The pedagogy is grounded in the students' reality, drawing upon suitable everyday-life examples to situate learning. It provides a clear order of abstraction activities that progress through kinaesthetic – iconic – symbolic representations while also connecting to everyday and mathematical language. Mathematical activities build students' fluency with mathematical procedures and skills as well as promoting their conceptual understanding (i.e., developing and reinforcing connections between mathematical ideas). During reflection, opportunities are made for students to reflect their learning back to their reality, thereby transferring their knowledge to new situations and further developing connections, including the formation of generalisations.

The XLR8 curriculum is presented to teachers as a series of module booklets, each nominally 5 weeks in duration. Each module is composed of several units, each of which corresponds to a single cycle of the RAMR pedagogical framework. The modules carefully explain the mathematical ideas of each unit and their structural relationships with one another. The ordering of the modules and units defines a conceptual sequence (referred to as the structured sequence) by which the structure of mathematical ideas is to be explored, which is further explained in the module booklets. Accompanying each module is a set of classroom resources, including worksheets, that serve as examples of intended classroom activities. The curriculum includes supervised test tasks which provide pre/post instruction data and which are marked in a timely manner by the research team such that they can be used by the teachers to inform their teaching. Assignment-style assessment tasks are also provided for each module. To support the teachers as they use the XLR8 curriculum, members of the research team regularly visit the teachers, both in their classes and for one-to-one meetings. During the in-class visits the researchers act as teacher-aides, assisting the teacher as needed. In the one-to-one meetings, the researchers act as a coach, discussing the curriculum with the teacher and collaborating with them to plan their teaching and to develop teaching resources. The teachers are also supported by meeting together in professional learning sessions, during which aspects of the XLR8 curriculum are presented and discussed.

Thus the curriculum is comprised of five features: 1) the structure of mathematical ideas embodied in each of the modules; 2) the conceptual sequence by which the modules and their units explore the structure; 3) the RAMR pedagogy that is described in each of the units with regard to the corresponding content (i.e., to follow the structured sequence); 4) the resources used to implement the structured sequence using the RAMR pedagogy; and 5) the assessment materials that generate diagnostic, formative and summative evidence of students' mathematical understanding.

LITERATURE REVIEW

Provided with any form of curriculum material, whether officially mandated curriculum or restructured curriculum materials, teachers are tasked with its interpretation. Via that interpretation, teachers make decisions, plan learning activities and prepare resources which will be enacted in their classroom. Teacher interpretation of curriculum and response to curriculum change is variously described in the literature. Doyle and Ponder (1977/78) identify three images of the teacher faced with curriculum change: *Stone-age Obstructionist, Pragmatic Skeptic, Rational Adopter* (Doyle & Ponder, 1977/78). The first image is of a teacher who rejects (and resists) change regardless of argument or material. The third image is of a teacher who accepts curriculum reform if good arguments are made and the materials appear to reflect these arguments. The second image is more complex and embodies the ecological consideration that teachers adapt curricula to the specific needs and environment of their students. Doyle and Ponder go on to describe the degree by which pragmatic skeptics embrace curriculum change is moderated by their perception of the innovation's practicality, in terms of instrumentality, congruence and cost. More recently, Basalam (2010) has defined a continuum of categories with which to characterise teachers' responses to curriculum change. The continuum ranges from *non-adopters* (including sub-categories of *rejecters* and *resisters*) through to *adopters* (including sub-categories of *partial-adopters, pragmatic-adopters* and *critical embracers*). In both cases, these categories seek to provide salient descriptions and insights regarding of teachers' adoption or adaptation of curriculum changes.

The interpretation of the intended curriculum to form the enacted curriculum is bound to vary in terms of its alignment to the intention of curriculum designers (Porter, 2006). This variance in teacher interpretation is influenced by a range of factors, including: their own beliefs about mathematics content and pedagogies in relation to their unique classrooms (McLaughlin & Talbert, 2001); resources provided as a part of the innovation, including the textbook (Little, 2002; Remillard, 2005); concern for immediate contingencies and consequences as a reaction to student responses rather than from evidence of long-term goals (Doyle & Ponder, 1977); and perceptions of the abilities and learning capacities of students within their classroom and their possible life trajectories and aspirations (Schoenfeld, 2008).

This literature provides a basis for identifying categories of responses to the XLR8 project's curriculum and for developing explanations regarding the varying degrees of teacher interpretation. This characterisation and explanation of individual teacher responses will in turn inform improvements to the support given to teachers such that the desirable sustained impact and long-term benefits of the project are achieved.

APPROACH

Participants in the XLR8 project in 2014 were 10 classroom teachers from four different schools, teaching approximately 180 students. Of these 10 teachers, five had also been involved in the project in 2013. The teachers had varying professional

backgrounds: some teachers were relatively junior (including one first-year graduate), others were mid-career and one was an experienced teacher (who was the Head of the Maths/Science Department in one school). Most of the teachers were mathematics trained. However, some were teaching out-of-field, having been selected to participate by their respective schools based upon their experience of teaching students with behavioural and/or additional learning needs.

Data gathering in regard to these teachers' practices of curriculum interpretation has included: field notes taken during lesson observations and one-to-one coaching sessions; video recordings of discussions during professional learning sessions; and individual semi-structured interviews conducted with each of the participating teachers at the end of each year. Both the first and second authors have met with, observed and/or interviewed all of the participating teachers, and so have been able to discuss their experiences and develop a shared understanding of each teacher. In particular, they have been able to characterise typical practices of the participating classroom teachers as they interpret the XLR8 curriculum.

Data analysis leading to the formulation of the continuum for characterising teacher interpretation was conducted by the first two authors as follows. First, with regard to the five features of the curriculum intervention (structure, sequence, pedagogy, resources and assessment), the first two authors proposed, discussed and refined statements that described the observed or reported practices of the participating teachers. These statements were written on sticky notes and assembled in columns (per teacher) and rows (per curriculum feature).

Second, within each curriculum feature (row), these descriptive statements were compared and sorted into groups based upon similarity. This sorting was guided by the literature: groups that aligned to adoptive or adaptive practices were sought. The sorting was refined when it became apparent that some practices reflected non-compliance with the curriculum (similar to Basalam's (2010) non-adopter category). The imperative of the project to situate learning within the students' reality necessitates teacher modification of the curriculum to suit their students. This led to the further refinement of the adaptive category into those teachers who questioned the curriculum and those who improved it. This comparison and sorting of the descriptive statements ultimately led to the proposition of four categories along the continuum: *resister*, *follower*, *questioner* and *improver*.

Third, the collected descriptive statements for each of the four continuum categories in relation to each curriculum feature were then synthesised into general descriptive statements regarding teachers' curriculum interpretation practices. As a result of trying to synthesise the general descriptions, the sorting of the specific statements was revisited and refined until the two authors reached a consensus, both in regard to the sorting and the generalised descriptions that resulted.

RESULTS AND DISCUSSION

The final result of synthesising the general descriptions is presented in Table 1.

Feature	Resister	Follower	Questioner	Improver
Structure	Knowledge of mathematical structure not evident in discussions or teaching. Focus on each mathematical idea in isolation.	Structural knowledge evident in discussions and teaching. Learning activities develop conceptual understanding.	Critiques own knowledge of mathematics, including structure. Discusses and queries structure as presented in curriculum.	Improves own knowledge of mathematical structure. Suggests refinements of the structure presented in the curriculum.
Sequence	Planning focussed on procedural fluency with end-point ideas. Ignores, skips or in-cohesively reorders curriculum activities.	Follows sequence as a series of isolated events. Lesson-level planning, little longer-term planning to build structural understanding.	Critically discusses sequence and the structure it develops. Longer term planning to develop structural understanding.	Adjust sequence to suit students, informed by structural knowledge. Participates in discussions regarding sequence improvement.
Pedagogy	Focussed upon mathematics phase to develop procedural fluency using rote-based instruction. Limited situated learning. Abstraction sequence absent or inconsistent use.	Routinely uses RAMR sequence without adjustment (most phases). Connects mathematical activities and language. Coherent situated learning in all RAMR phases.	Actively reflects upon and discusses teaching and learning in terms of using the RAMR cycle.	Recommends refinements to RAMR-based curriculum in terms of classroom practicality and students' development of understanding.

Table 1: Feature-wise characterisation of the interpretation continuum.

Feature	Resister	Follower	Questioner	Improver
Resources	Uses own resources instead of those provided, which do not align to the curriculum intentions.	Uses provided resources and finds similar resources that are aligned to curriculum intentions.	Critically reviews resources in terms of students' needs and curriculum intentions.	Collects, creates, improves and shares resources that are aligned to curriculum intentions.
Assessment	Formal assessment used only for reporting. Focussed upon procedural fluency not conceptual understanding or ways of working.	Uses assessment data to inform planning.	Queries content, coverage, form and language of assessment items.	Suggests improvements and makes modifications to assessment items to address perceived weaknesses.

Table 1 (cont.): Feature-wise characterisation of the interpretation continuum.

Guided by the continuum of descriptors presented in Table 1, two XLR8 teachers (Teacher A and Teacher B) were profiled. This profiling is summarised in Table 2 and then the profiles of each teacher are discussed in turn. As can be seen in Table 2, each teacher varied in the degree to which they interpreted the five curriculum features. For some features, teachers were positioned on the boundary of two categories. That is, a teacher cannot be simply categorised as Resister, Follower, Questioner or Improver.

Feature	Resister	Follower	Questioner	Improver
Structure	A		B	
Sequence		A		B
Pedagogy	A			B
Resources		A B		
Assessment		A	B	

Table 2: Interpretation profiles of Teachers A and B.

Teacher A was a newly-graduated Mathematics teacher: 2014 was her first year of teaching. Overall, the degree to which she interpreted the XLR8 curriculum could be described as a resistive follower. Observations and discussions with the teacher suggested she had a weak understanding of the structure of mathematical ideas, at least

with respect to the low-level content that she was teaching to her XLR8 class. She made efforts to follow the XLR8 structured sequence, but often rearranged the suggested order of activities such that the structured sequence was not adhered to. Her planning was very short-term (usually limited to the activities of the next lesson) and infrequently considered the development of big ideas across a module. She resisted using the RAMR cycle to base her teaching upon, citing that the students were unable to behave appropriately when attempting the more physical activities in the Abstraction phase. Teacher A often used her own resources, however they usually focussed upon practising procedural skills (the importance of which she emphasised during one-to-one discussions) and were sometimes misaligned to the objective of the curriculum units in which they were used. Whilst she administered the pre/post tests and assignment-style assessment tasks, she only partially drew upon the assessment data to inform her teaching, instead, relying upon anecdotal observations that were based upon her own, apparently weak, structural understanding.

Teacher B was an experienced Mathematics teacher and was the Head of Department at his school. 2014 was his second year of teaching using the XLR8 curriculum. In contrast to Teacher A, Teacher B provided evidence of a much more richly connected understanding of mathematics, was critical of his understanding and used his connected understanding to improve the curriculum sequence. This deeper structural understanding was also reflected in the way in which he refined his understanding and use of the RAMR pedagogy to better develop students' understanding and the ways in which he used assessment data to guide his teaching. Interestingly, Teacher B seemed less inclined to modify the resources that were provided, instead preferring to use what was provided in the ways that were suggested.

CONCLUSION

The XLR8 project involves teachers in trialling material developed by researchers with the outcomes of producing improved teaching and learning, innovative approaches to professional learning, classroom materials and theory with respect to teacher change and student learning. Based upon literature and data taken from the XLR8 classrooms, a continuum has been proposed to describe the degree to which the XLR8 teachers adhere to, query or improve the XLR8 curriculum with regard to its five features. It is anticipated that the best outcomes will emerge when teachers are questioning and improving the curriculum, that is, when they enhance learning in classrooms and act as co-researchers with respect to learning materials and student learning. However, as illustrated in the profile of Teacher A, some teachers tend towards resistance or following. The construction of the continuum and its use to characterise Teachers A and B has raised the question "How do the interpretation practices across the five curriculum features relate to one another?"

Moving forward, this continuum will be used as a basis to structure XLR8 classroom observations and discussions with teachers regarding their interpretation practices. Further use of the continuum will lead to the refinement of the continuum descriptors

and the development of explanations regarding inter-feature relationships (e.g., the influence of teachers' interpretation of mathematical structure upon assessment) and external factors which influence the teachers' curriculum interpretation. Importantly, this more focussed data gathering and analysis will lead to the identification of opportunities for the XLR8 project to provide professional learning support that will enhance teaching practices, the curriculum and, ultimately, student learning outcomes.

ACKNOWLEDGEMENT

The research reported in this paper is supported by an Australian Research Council Linkage Grant (LP 120200591) awarded to Cooper, English, and Nutchey. Opinions expressed in this paper are those of the authors and not of the Council. The XLR8 researchers would like to acknowledge the contributions made to the project by the participating schools, teachers and students.

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